U.S. Army Corps
of Engineers
New England District

INVENTORY INSPECTION REPORT

HOPKINTON LAKE SERVICE BRIDGE
HOPKINTON LAKE
CONTOOCOOK, NEW HAMPSHIRE

August 1997

New England District

HOPKINTON LAKE
SERVICE BRIDGE
INVENTORY INSPECTION REPORT

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I. EXECUTIVE SUMMARY

1. PURPOSE AND SCOPE: The purpose of this inspection is to evaluate the service bridge at Hopkinton Lake, West Hopkinton, New Hampshire, to detect any conditions of structural distress or operational inadequacy, and to increase the useful life and assure the continued safety of the structure.

2. AUTHORITY: The basis for this inspection is contained in ER 1110-2-111 "Periodic Safety Inspection and Continuing Evaluation of USACE Bridges," 30 April 1997.

3. REFERENCES: The field inspection and evaluation was performed in accordance with CFR 23 part 650 the "National Bridge Inspection Standard" (NBIS), the Federal Highway Administration "Bridge Inspector's Training Manual/90" dated July 1991 (revised March 1995), and the AASHTO "Manual for Maintenance Inspection of Bridges" 1983.

4. PREVIOUS INSPECTIONS: The service bridge at Hopkinton Lake was last inspected in April 1992 as part of the Periodic Inspection Program for Dams and Appurtenant Structures, in accordance with ER 1110-2-100. The bridge is not located on a public road and is not technically under authority of the NBIS. However, guidance contained in ER 1110-2-111 requires all bridges owned or maintained by the United States Army Corps of Engineers be inspected in accordance with the NBIS, regardless of whether it is a public access road or not. Based on the above, as well as the overall good to excellent condition of the structure, the bridge will continue to be inspected on a 5-year cycle, coincident with the Periodic Inspections. This inspection and report is considered the initial Inventory Inspection of the service bridge at Hopkinton Lake, in accordance with section 5.d. of ER 1110-2-111.

5. RECOMMENDATIONS: Repatch the spall at the concrete haunch at the control tower and replace the damaged bridge deck guardrail. Smooth the transition between the concrete bridge deck and the bituminous approach.

II. BRIDGE DESCRIPTION AND HISTORY

The service bridge was constructed in 1959, as part of the Hopkinton Lake flood control project, on the Contoocook River in the town of Hopkinton, New Hampshire. Appendix C contains a location map of the bridge. The bridge was constructed to provide access from the crest of the dam to the control tower, which houses the outlet works for the dam. Although the bridge is closed to public access, terminates at the gate tower, and is subject to minimal traffic, it is considered a critical structure for flood control operations at Hopkinton Lake.

The bridge is 45 feet long and is a single span. It is a composite structure with two plate girders supporting a reinforced concrete deck (photo 1). The bridge is oriented approximately 90° from the approach road at the crest of the dam. The bridge roadway is 12'-0" wide between 1'-1" wide by 10" high curbs. Both curbs support aluminum post and pipe guard rails. The concrete deck varies in thickness from 8" at the curbs to 9" at the centerline. The plate girders are 36" deep

(36 WF 150) and are spaced 9'-0" center to center. The bridge is simply supported by a concrete stub abutment at the dam crest and by two reinforced concrete haunches at the control tower.

III. DESIGN CRITERIA

Loading conditions, design assumptions and other design criteria are based on applicable parts of the Engineering Manual for Civil Works issued by the Office of the Chief of Engineers. Accepted engineering practice was employed, including AASHTO Design Specifications - 1959 Edition, in cases where the Engineering Manual for Civil Works does not apply. The live load used for design of the bridge was a standard AASHTO HS-20 truck loading. The original contract specifications called for reinforcing steel conforming to ASTM A305-50T, with a working stress of 20,000 psi. Structural steel is designed for the working stresses of ordinary bridge and building steel (minimum yield stress 33,000 psi minimum). The basic working stress is 18,000 psi for bridge steel. The concrete was specified to have a working stress of 1,200 psi and an ultimate compressive strength of 3,000 psi, minimum. Appendix C contains detailed construction drawings of the bridge.

IV. INSPECTION PROCEDURE

The field inspection of this bridge was conducted on 29 May 1997. The inspection was performed in accordance with the Federal Highway Administration "Bridge Inspector's Training Manual/90" and the AASHTO "Manual for Maintenance Inspection of Bridges" 1983, as required by ER 1110-2-111. The weather was sunny and the temperature was 75°F. The field inspection consisted of a complete visual investigation of all bridge components above ground. Hammers, probing rods, and tape measures were used. Testing and/or instrumentation of individual members was not included as part of this inspection. Color photographs were taken using a 35 mm camera and are included in Appendix A of this report.

The underside of the bridge was inspected using a Paxton-Mitchell "Snooper Mark V," which complies with ANSI /SIA A92.8-1993 for Vehicle-Mounted Bridge Inspection and Maintenance Devices. The "Snooper" is a truck-mounted, self-contained hydraulic unit from which inspection personnel can be lowered by boom to positions beneath the bridge deck while the truck carrier remains on the bridge deck. (see photo 1). The "Snooper" provided complete access to the underside of the bridge, including the bearings and bridge seats.

A bridge inspection form was completed and is provided in Appendix B of this report. Numerical ratings are used to describe the general condition of major bridge components. The rating system is based on that presented in the "Bridge Inspector's Training Manual/90," and is reproduced in Appendix B of this report.

V. FRACTURE CRITICAL EVALUATION

A Fracture Critical Member (FCM) is a member in tension or with a tension element, whose failure would probably cause a portion of or the entire bridge to collapse. FCMs are subject to fracture due to either brittle or fatigue failure. Brittle fracture of a steel member can be caused by the sudden application of a load which develops high total stresses at the location of a defect in the metal (i.e, nick, notch, crack) and is more likely to occur during cold weather when the steel tends to be more brittle. The formation of a fatigue crack in a steel member is caused by repeated cycles of stress due to live loads. The fatigue life of a steel bridge is dependent on the magnitude of the applied stresses, and the fatigue strength of the materials and their connection details. The FCMs on the service bridge are the steel girders. The girders are in very good condition. Therefore physical testing or evaluation of the girders is not warranted at this time, although special attention should be given them during subsequent scheduled inspections.

VI. INSPECTION RESULTS

1. APPROACH ROADWAY: The bituminous approach roadway runs along the crest of the dam and is in good condition. There is a 90° turn from the two-lane approach road to the bridge deck. The bituminous pavement at the approach to the deck has settled (photo 2). The guardrail system along the approach is in good condition (photo 3).

2. DECK: The deck is in good condition. The concrete surface shows minor wear and abrasion, and there are no cracks observed at the top surface or underside. The curbs and drains are in very good condition but the top eastside aluminum rail has a minor dent (photo 4). Utility conduits, which run the length of the deck along the exterior edges of the east and west girders, are in good condition but there is oil and grease on the utility conduits at the abutment (photo 5).

3. SUPERSTRUCTURE: The expansion (located at the north, abutment end) and fixed (located at the south, control tower end) bearings are in good condition with minor corrosion (photo 6). The clearance between the abutment back walls and the steel girders is as follows:

North Abutment:

East Girder - Top	2-1/4"
- Bottom	2-1/4"
West Girder - Top	2-7/8"
- Bottom	2-1/2"

South Abutment:

East Girder - Top	1-1/2"
- Bottom	1-3/4"
West Girder - Top	1-3/4"
- Bottom	2"

The condition of the girders and diaphragms is very good. There is very little corrosion on webs, flanges, and diaphragms and minor rusting of bearing plates and bolts (photo 6)

4. SUBSTRUCTURE: The southern abutment is in good condition with a minor spall at the eastern intersection of the back wall and the reinforced concrete haunch (photo 7). Rusty spots are evident along the steel plates against the concrete backwall walls at north abutment (photo 8).

5. TRAFFIC SAFETY FEATURES: The bridge is not open to the public, and only carries maintenance vehicles out to the crest of the dam. The bridge guardrail system is in good condition. The bituminous pavement on the approach should be leveled to create a smooth transition for traffic.

6. CHANNEL: Not Applicable.

VII. SUMMARY

1. CONCLUSIONS: The overall condition of the bridge is good, with no signs of structural distress. The deficiencies noted are not of a serious nature and do not compromise the functional capacity or the safety of the bridge.

2. RECOMMENDATIONS: Repairing the minor concrete spall at the east haunch of the control tower and replacing the dented bridge guard railing should be included in the next concrete or bridge contract at the project.

VIII. LOAD RATING ANALYSIS

The bridge is rated in accordance with the AASHTO "Manual for Maintenance Inspection of Bridges" 1983. The ratings are calculated at two stress levels, as defined below:

1. INVENTORY RATING: The first (lower) rating is referred to as the Inventory Rating. The Inventory Rating is the load (associated with the particular vehicle type being rated), which can safely be carried by the structure for an indefinite period of time. A special permit is required for all vehicles heavier than the Inventory Rating. These vehicles are called "Permit Loads."

2. OPERATING RATING: The second (upper) rating is referred to as the Operating Rating. The Operating Rating is the absolute maximum permissible load (associated with the particular vehicle type being rated) to which a structure may be subjected. Permit loads, as described above, must be distributed such that the structural capacity, as determined by the Operating Rating, is not exceeded.

3. LOAD RATING RESULTS: The live load used in determining both the Inventory and Operating Ratings is the standard AASHTO type HS-20 vehicle. Because the bridge is narrow and is aligned 90° from the west approach, it was assumed that all traffic crossing the bridge would be traveling slowly, and therefore impact loading was not included in the analysis. Each member of the bridge was analyzed for both Inventory and Operating Ratings. Load rating calculations are provided in Appendix D of this report. Results of the load rating analysis are as follows:

	RATING IN TONS	
VEHICLE TYPE	**INVENTORY**	**OPERATING**
HS-20	**47.88**	**79.50**

The inventory and operating rating is limited by the capacity of the deck.

APPENDIX A

PHOTOGRAPHS

Photo 1: Hopkinton Service Bridge (View Looking Southeast)

Photo 2: Settlement at the Bituminous/Deck Interface

Photo 3: Guardrail System Along the Bridge Approach (View looking Northeast)

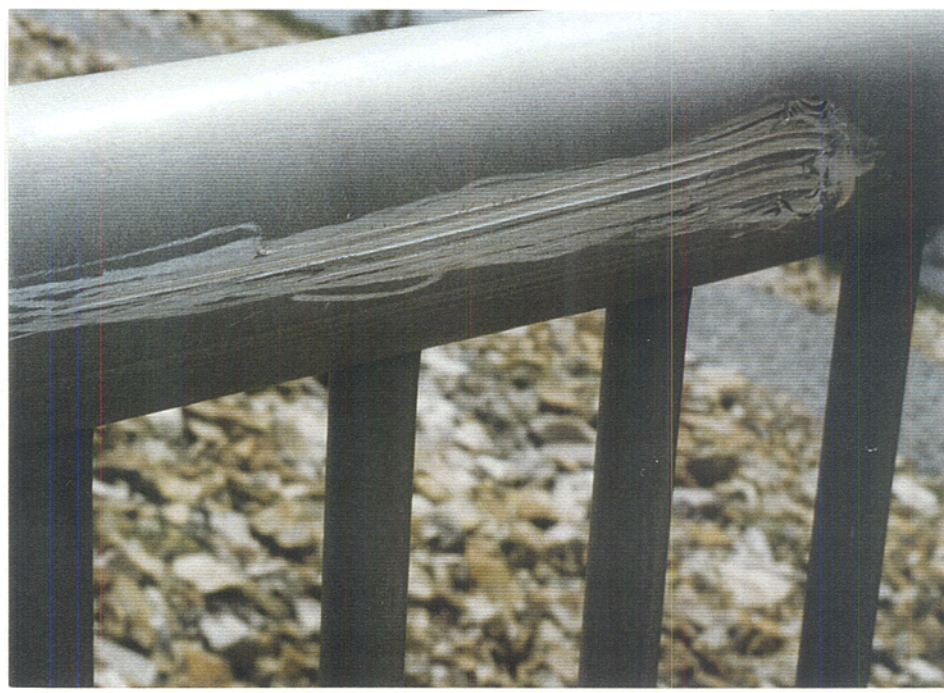


Photo 4: Minor Dent at the East Bridge Deck Guardrail

Photo 5: Oil and Grease on Utility Conduits at the Abutment

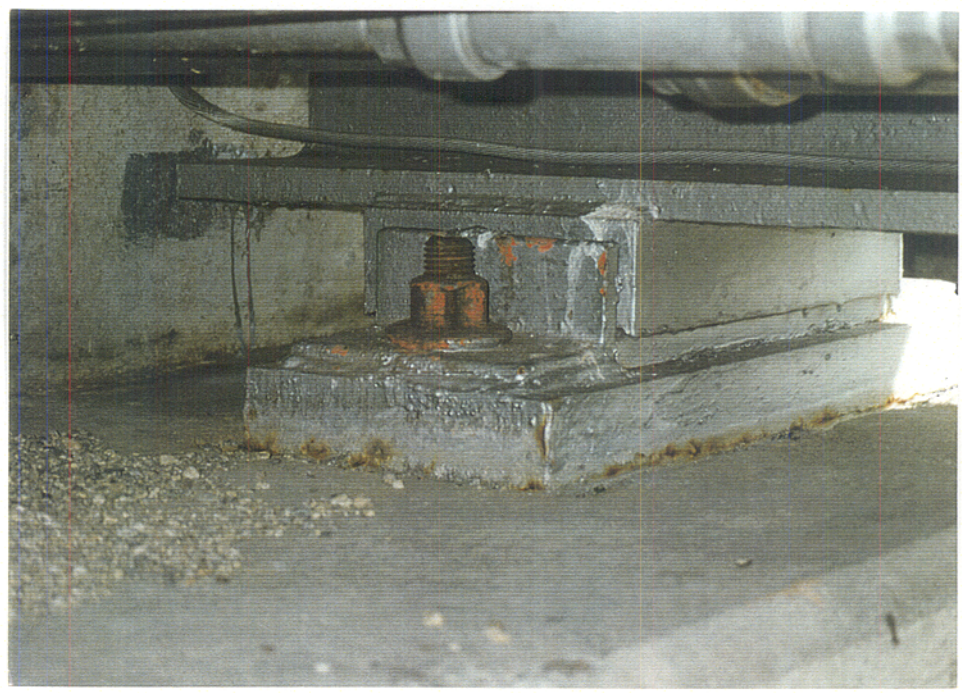


Photo 6: Minor Rusting of the Steel Bearing Plates and Bolts
At the North Abutment

Photo 7: Spall at the Reinforced Concrete Haunch.

Photo 8: Rusty Spots At the North Abutment Concrete Backwall

CONDITION RATING GUIDELINES

The following numerical rating guidelines are taken from the "Bridge Inspector's Training Manual/90," and are used to report the condition of different bridge components.

Code	Description
N	NOT APPLICABLE
9	EXCELLENT CONDITION
8	VERY GOOD CONDITION -No problems noted.
7	GOOD CONDITION - Some minor problems noted.
6	SATISFACTORY CONDITION - Structural elements show some minor deterioration.
5	FAIR CONDITION - All primary structural elements are sound, but may have minor section loss, cracking, spalling or scour.
4	POOR CONDITION - Advanced section loss, deterioration, spalling or scour.
3	SERIOUS CONDITION - Loss of section, deterioration, spalling or scour have seriously affected primary structural components. Local failures are possible. Fatigue cracks in steel, or sheer cracks in concrete, may be present.
2	CRITICAL CONDITION - Advanced deterioration of primary structural elements. Fatigue cracks in steel, or sheer cracks in concrete, may be present, or scour may have removed substructure support. Unless closely monitored, it may be necessary to close the bridge until corrective action is taken.
1	"IMMINENT" FAILURE CONDITION - Major deterioration or section loss present in critical structural components, or obvious vertical or horizontal movement affecting structure stability. Bridge is closed to traffic, but corrective action may put the bridge back in light service.
0	FAILED CONDITION - Out of service and beyond corrective action.

STRUCTURES INSPECTION FIELD REPORT

ROUTINE INSPECTION

town	bridge dept. no.	8-structure no.	90-date inspected
HOPKINTON, NH			29 MAY 1997

2-dist.	104-highway system	22-owner	27-year built	106-year rebuilt	11-milepoint
	0 - NOT in NHS	US Army Corps Engrs	1959		

43-structure type: 302 - Steel Plate Girder	quality control engineer: Nick Forbes
07-facility carried: Access Road to Control Tower	team leader: Joe Colucci
06-features intersected: Upstream Embankment - Dam	team members: Francis Fung

Item 58 DECK		Item 59 SUPERSTRUCTURE		Item 60 SUBSTRUCTURE	
	7		8		7
1. Wearing Surface	7	1. Bearing Devices	7	1. Abutments	
2. Deck-Condition	7	2. Stringers	N	a-Wings	7
3. Stay in Place Forms	N	3. Diaphragms	8	b-Backwall	7
4. Curbs	8	4. Girders or Beams	8	c-Bridge Seats	8
5. Median	N	5. Floor Beams	N	d-Breastwall	7
6. Sidewalks	N	6. Trusses	N	e-Footings	N
7. Parapet	8	7. Rivets or Bolts	7	f-Piles	N
8. Railing	7	8. Welds	8	g-Erosion	N
9. Anti Missile Fence	N	9. Collision Damage	7	h-Settlement	8
10. Drains	8	10. Load Deflection	8	2. Piers or Bents	
11. Lighting Standards	N	11. Member Alignment	8	a-Caps	N
12. Utilities	7	12. Load Vibration	8	b-Column	N
13. Deck Joints	7	13. Paint-Epoxy	8	c-Web	N
14. Approach Settlement	6	14. Year Painted		d-Footing	N
		15. Under Clearance ____ ft ____ in		e-Piles	N
		Clearance Signs ☐ yes ☑ no		f-Scour	N
				g-Settlement	N
				3. Collision Damage	N
				4. Hydraulic-Adequacy	N

Actual Posting	H	3	3S2	Single
	N	N	N	☐
Recommended Posting From Rating Book	☐	☐	☐	☐

SIGNS IN PLACE Y or N	at bridge	advance
	N	N
LEGIBILITY	☐	☐

Overhead Signs (attached to bridge) ☐ yes ☑ no

1. Welds ☐
2. Bolts ☐
3. Condition ☐

Item93b U/W Inspection Date: ____

ITEM 61-channel and channel protection: N

1. channel scour	☐	5. rip rap or slope paving	☐
2. embankment erosion	☐	6. effectiveness	☐
3. fender system	☐	7. debris	☐
4. spur dikes & jetties	☐	8. vegetation	☐

36-Traffic Safety features

	36	condition
1. bridge railing	N	7
2. transitions	N	-
3. approach guardrail	N	7
4. guardrail terminal	N	-

X=UNKNOWN NA=NOT APPLICABLE IA=INACCESSIBLE

HIGHWAY BRIDGE STRUCTURE INVENTORY AND APPRAISAL 11/05/97

********** IDENTIFICATION **********
1 State - New Hampshire 331
200 COE MSC -NORTH ATLANTIC
201 COE District -DIS/DIV IS UNDEFINED.
202 COE Bridge Number : CENNEDNH3310014
8 STRUCTURE NUMBER : CENNEDNH3310014
5 Inventory Route -on 168000000
2 Highway Dist. : 00
3 County Code:000 4 Place code:
6 Features Intrsct:ACCESS ROAD TO DAM
7 Facility Carried:GATEHOUSE ACCESS
9 Location : WEST HOPKINTON, NH
11 Milepoint : .
16 Lat:43D 11.2' 17 Long:071D 43.5'
98 Border Br State :
99 Border Br Stru #:

****** STRUCTURE TYPE & MATERIAL ******
43 Stru Main Material- Steel
Type- Stringer/Multibeam/Girder 302
44 Stru App Material- Other
Type- Other 000
45 # of Main Spans : 001
46 # of App Spans : 0000
107 Deck Stru -Concrete CIP 1
108 Wearing Surf/Protective Sys type
A Wearing Surface - Concrete 1
B Membrane - None 0
C Deck Protection - None 0

********** AGE & SERVICE **********
27 Year Built : 1959
106 Year Reconstructed :
42 Type of Service on -Highway
under: Other 10
28 Lanes On Stru: 01 Under Stru: 00
29 ADT : 000005
30 Yr of ADT : 97 109 Truck ADT : 00%
19 Bypass, Detour Length (miles) 99

********** GEOMETRIC DATA **********
48 Length of Max Span (ft) : 0045
49 Structure Length (ft) : 000047
50 Curb/Sidewalk Width L:01.0' R:01.0'
51 Bridge Width, Curb-to-Curb : 012.0'
52 Deck Width, out-to-out : 014.0'
32 Approach Rdwy Width : 010'
33 Bridge median - No median 0
34 Skew : 00 deg 35 Stru Flared: 0
10 Inventory Rt Min Vert Clrn : 99'99"
47 Inv. Rt Total Horz Clrn : 10.0'
53 Min Vert Clrn over Rdwy : 99'99"
54 Min Vert Underclearance :N00'00"
55 Min Lateral R Underclrnc : N99'9"
56 Min Lateral L Underclrnc : 99'9"

Bridge record was updated on : 11/05/97

(App C) Sufficiency Rating = 076.0
Status = Functional obselete

******* NAVIGATION DATA *******
38 Navigation Control :N
111 Pier/Abutment Protection:
39 Navigation Vert Clrn : 000'
116 Vert Lift Bridge Min Clr: '
40 Navigation Horz Clrn :0000'

********* CLASSIFICATION *********
112 NBIS Bridge Length : Y
104 Hwy System of Inventory Rt: 0
26 Functional Classification : 06
100 Defense Hwy Designation : 0
101 Parallel Stru Designation : N
102 Direction of Traffic : 3
103 Temperary Stru Designation:
110 Designated Natl Network : 0
20 Toll : 3
21 Main - Military/Corps : 70
22 Owner- Military/Corps : 70
37 Historical Significance : 5

********** CONDITIONS **********
58 Deck : 7
59 Superstructure : 8
60 Substructure : 7
61 Channel Protection : N
62 Culverts : N

****** LOAD RATING & POSTING ******
31 Design Load - HS 20 : 5
64 Operating Rating : 280
66 Inventory Rating : 248
70 Posting - Unknown : 5
41 Stru Open/Posted/Closed : B
- Open, posting recommended

********** APPRAISAL **********
67 Structure Evaluation : 7
68 Deck Geometry : 6
69 Underclearance Vert/Horz : N
71 Waterway Adequacy : N
72 Approach Roadway Alignmen : 3
36 Traffic Safty Features :NNNN
113 Scour Critical Bridges : N

****** PROPOSED IMPROVEMENTS *****
75 Type of Work : 000
76 Length of Stru Imprvmt : 000000
94 Bridge Improvement Cost: 000000
95 Roadway Imprvmnt Cost : 000000
96 Total Project Cost (K) : 000000
97 Yr of Imprvmnt Cost Est: 00
114 Future ADT : 000000
115 Year of Future ADT :

********** INSPECTION **********
90 Insp Date: 05/97 91 Freq: 24mo
92 Critical Feature Insp 93 Date
A Frac. Crit Detail :Y 24 /
B Underwater Insp : /
C Other Special Insp: /
203 Insp Off -DIS/DIV IS UNDEFINED.
204 Inspector:JOE COLUCCI
205 Insp Cost:

1	State (331)	-	New Hampshire
200	COE MSC	-	NORTH ATLANTIC
201	COE District	-	DIS/DIV IS UNDEFINED.
202	COE Bridge Number	:	CENNEDNH3310014
8	STRUCTURE NUMBER	:	CENNEDNH3310014
211	MACON	:	
212	Installation Name	:	
213	Military Load Class Wheeled	:	
214	Military Load Class Tracked	:	
215	Installation Number (IFS)	:	
216	Seismic Category	:	
217	Acceleration Coefficient	:	
218	Soil Site Condition	:	

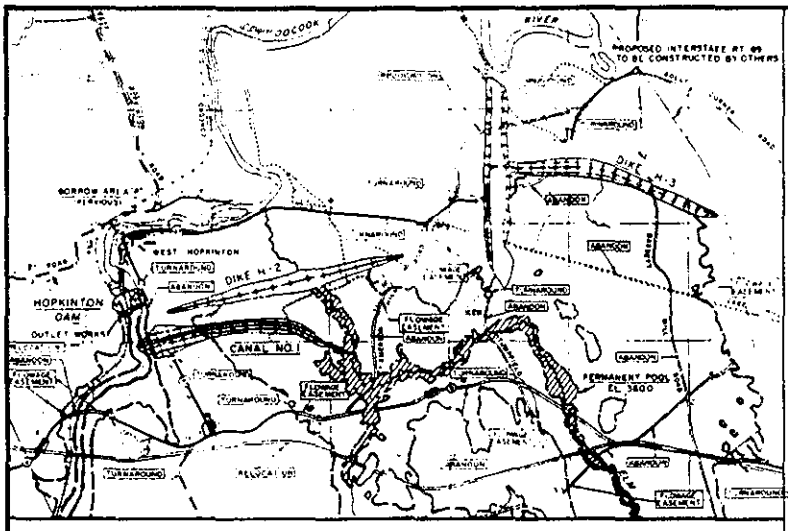
APPENDIX C

LOCATION MAP & DETAILED DRAWINGS

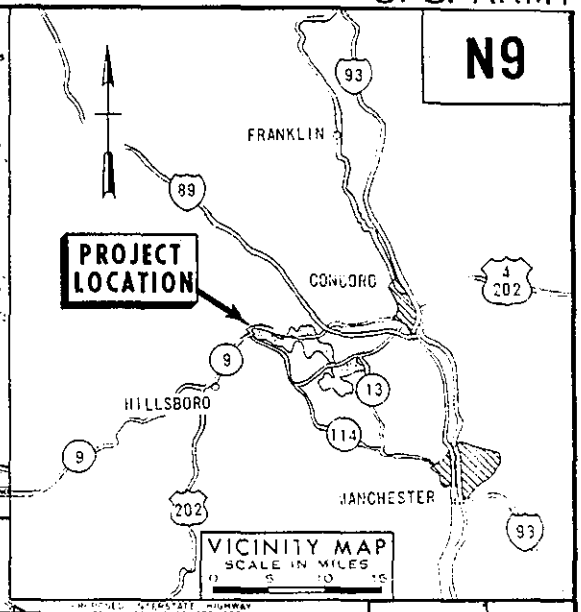
CORPS OF ENGINEERS

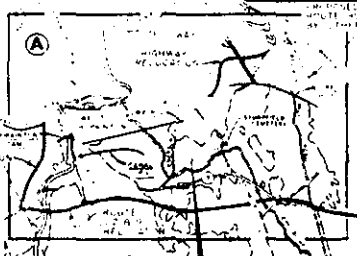
U. S. ARMY

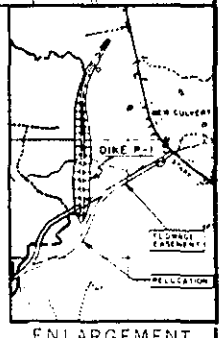
N9



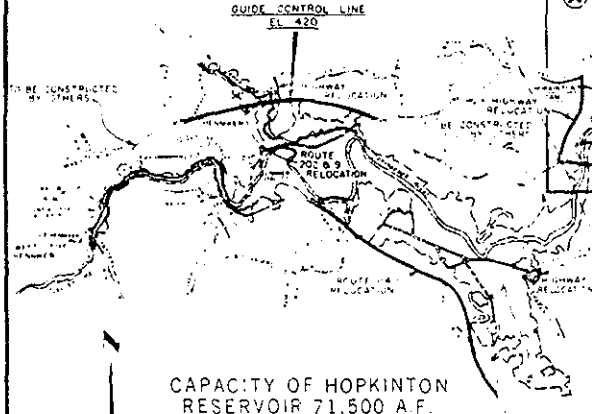
ENLARGEMENT OF AREA A





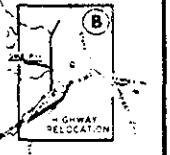


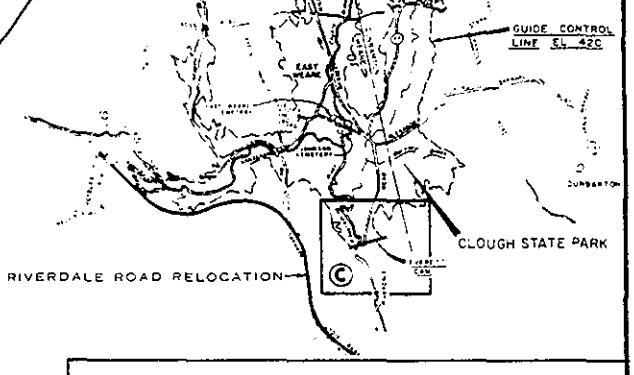
ENLARGEMENT OF AREA B

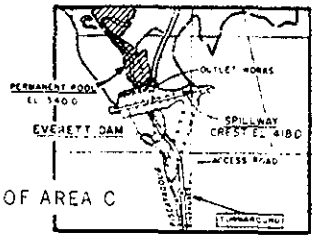


CAPACITY OF HOPKINTON RESERVOIR 71,500 A.F.

CAPACITY OF EVERETT RESERVOIR 37,500 A.F.







ENLARGEMENT OF AREA C

MERRIMACK RIVER BASIN

HOPKINTON-EVERETT LAKES

RESERVOIR MAP

30 SEPTEMBER 1984

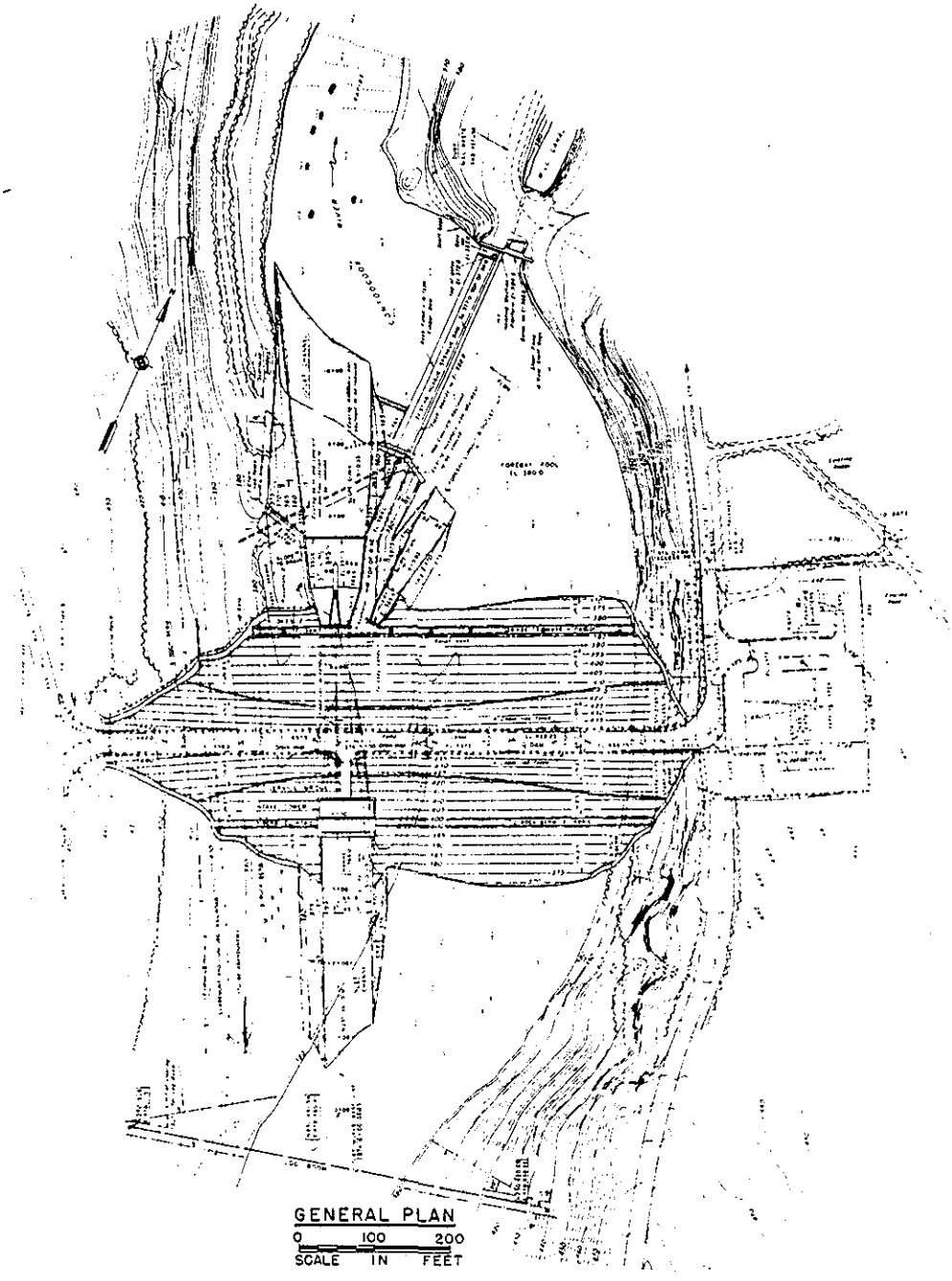
CONTOOCOOK & PISCATAQUOG RIVERS N.H.

SCALE IN FEET
2000 0 2000 6000

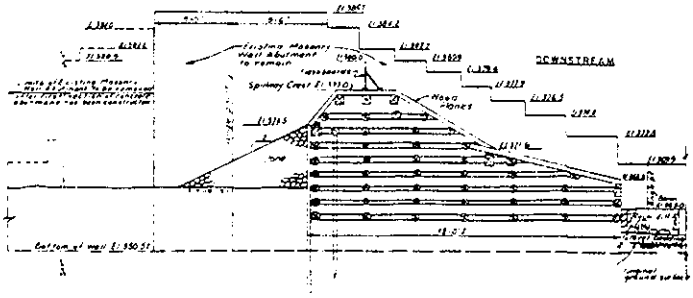
NEW ENGLAND DIVISION WALTHAM MASS.

CORPS OF ENGINEERS U. S. ARMY

N9a



GENERAL PLAN
0 100 200
SCALE IN FEET



SECTION THRU EXISTING HOAGUE-SPRAGUE DAM

MERRIMACK RIVER BASIN

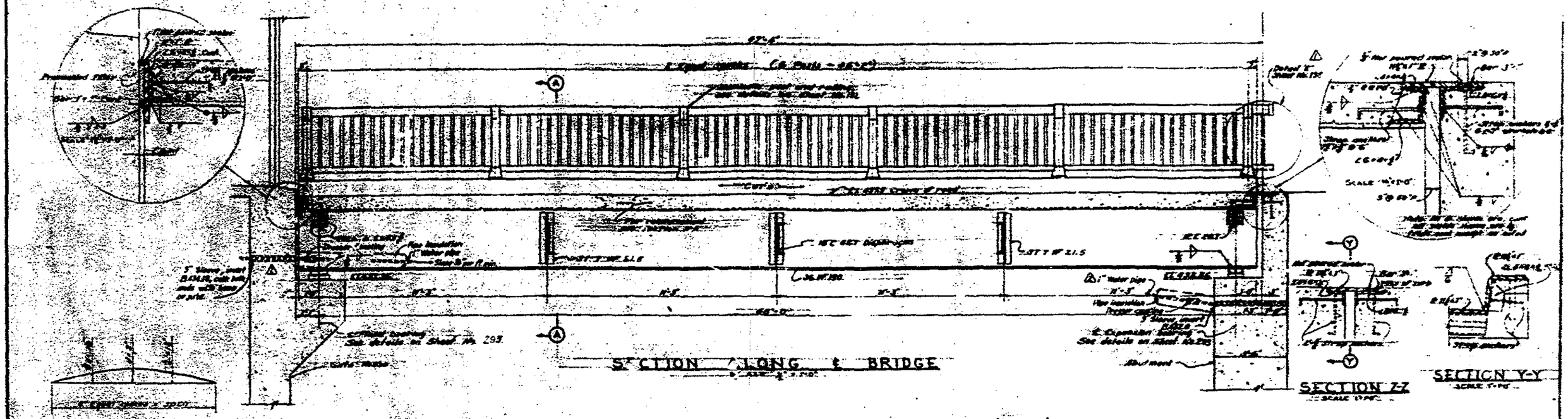
HOPKINTON-EVERETT LAKES

HOPKINTON DAM
GENERAL PLAN

30 SEPTEMBER 1984

CONTOOCOOK & PISCATAQUOG RIVERS N.H.

NEW ENGLAND DIVISION WALTHAM, MASS.

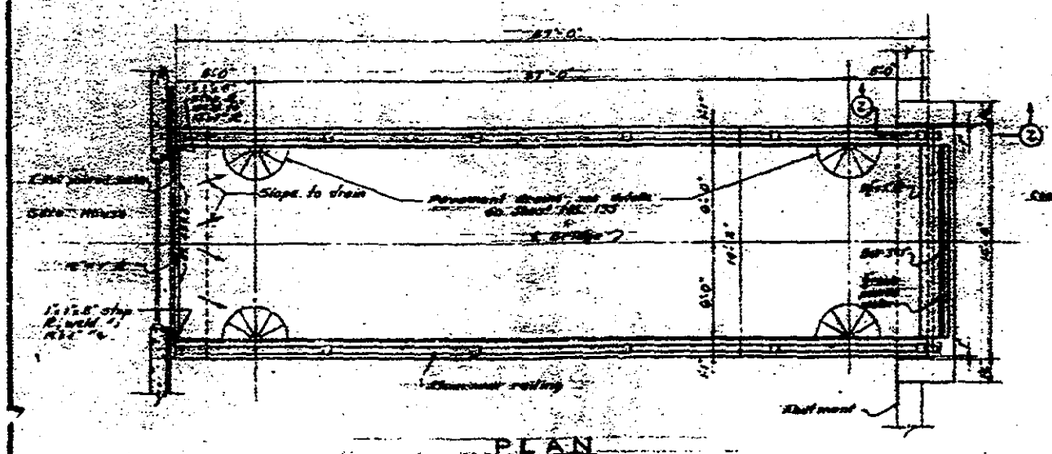


SECTION ALONG ℄ BRIDGE

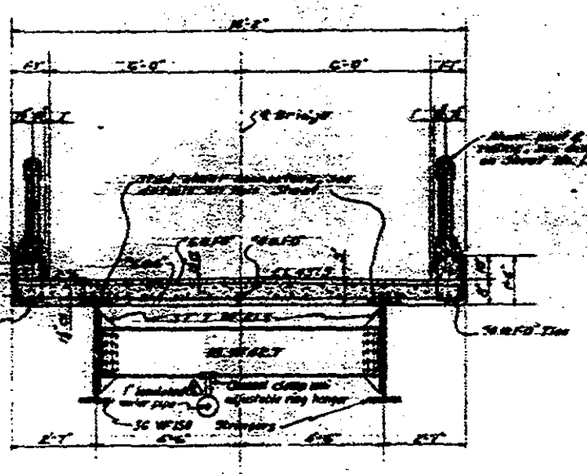
SECTION Z-Z

SECTION Y-Y

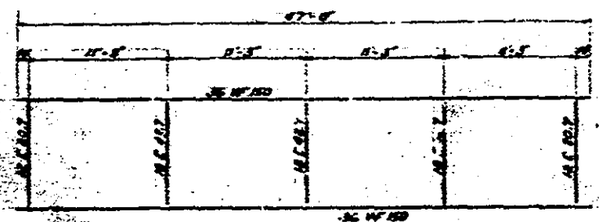
CAMBER DIAGRAM



PLAN



SECTION A-A

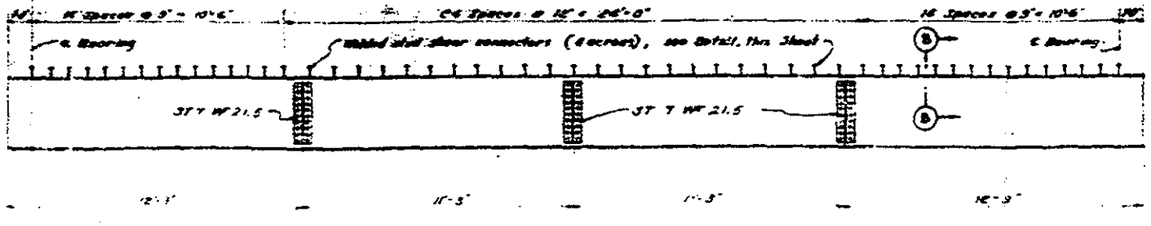


FRAMING PLAN

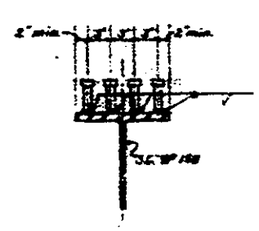
Record Drawing
Contract No. DA-19-016-CIVENG-60-2

NOTES:

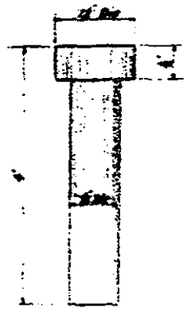
1. For general notes see Sheet No. 252.
2. All concrete in the Service Bridge Roadment will be paid for under Item No. 136.
3. All concrete in bridge superstructure will be paid for under Item No. 137.
4. All structural steel in Service Bridge, except aluminum railing, will be paid for under Item No. 149.
5. Aluminum railing will be paid for under Item No. 150.
6. Steel reinforcement will be paid for under Item No. 140.
7. Pipe insulation shall consist of 2" thickness of tar felt wrapped in weather proof jacket. 2 layer of saturated wool felt shall be installed between the pipe and the tar felt.



STRINGER ELEVATION



SECTION B-B



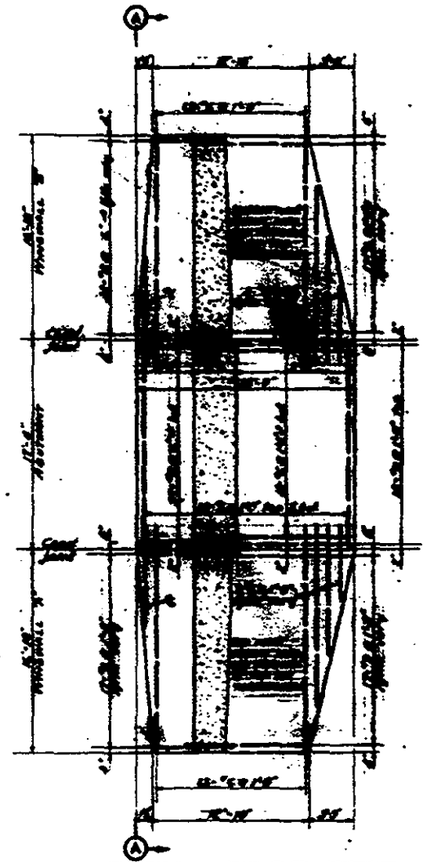
TYPICAL STUD

SHEAR CONNECTOR DETAILS

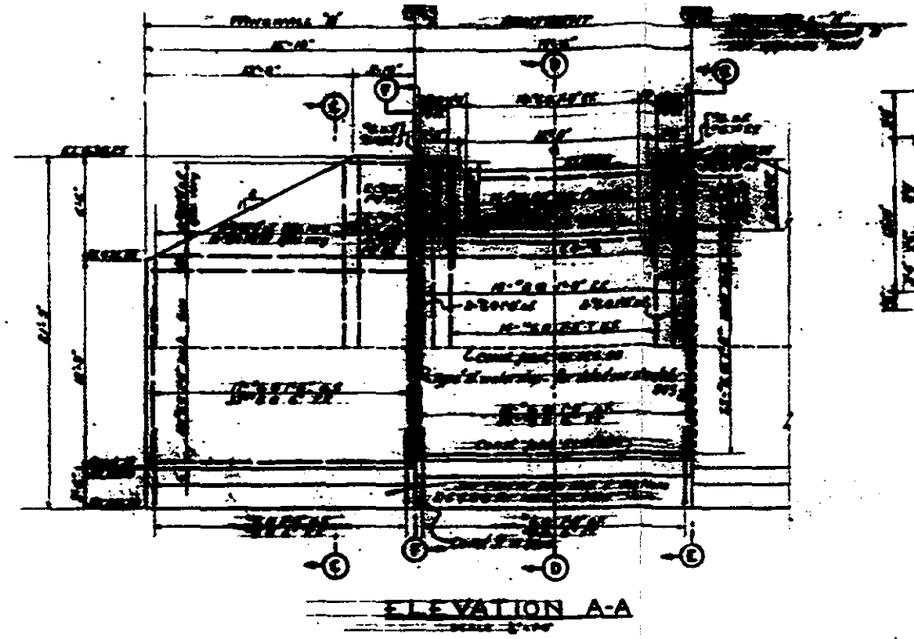
U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

MERRIMACK RIVER FLOOD CONTROL
HOPKINTON-EVERETT RESERVOIR
HOPKINTON DAM
SERVICE BRIDGE
DETAILS
CONTOOCOOK & PISCATAQUOG RIVERS NEW HAMPSHIRE

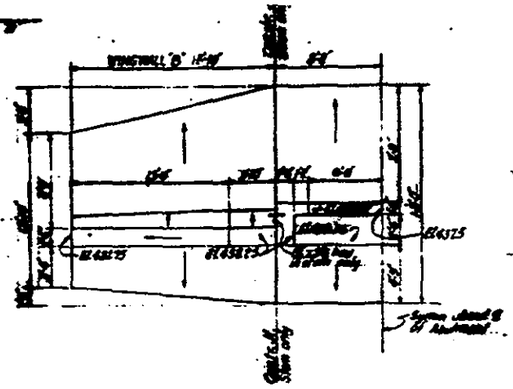
DATE: JULY 1959



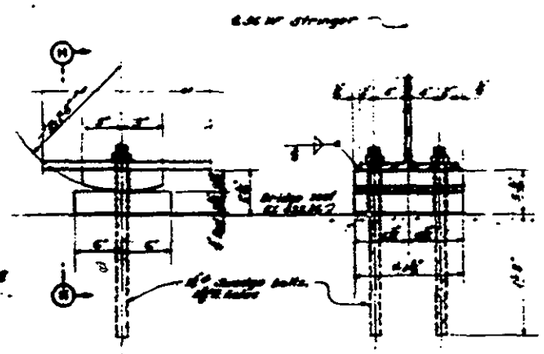
PLAN — BASE SLAB



ELEVATION A-A

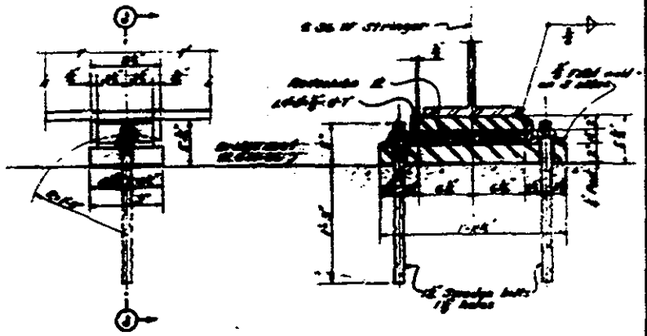


HALF PLAN



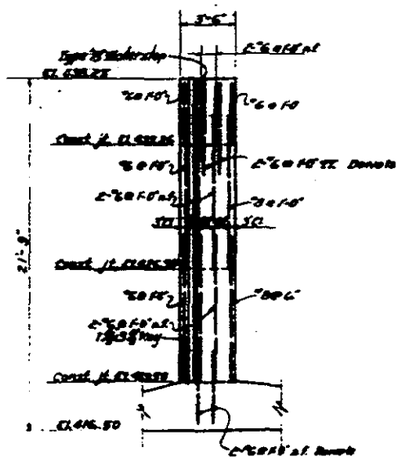
ELEVATION — SECTION H-H

FIXED BEARING DETAILS



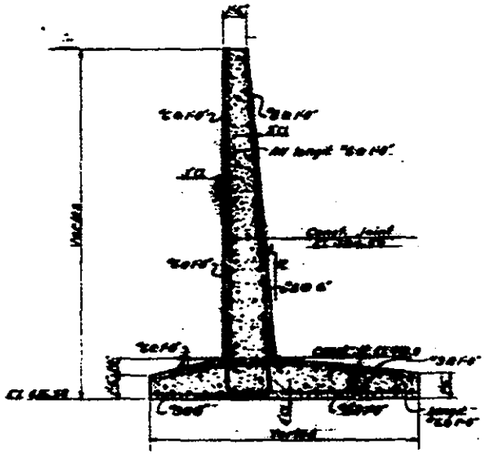
ELEVATION — SECTION J-J

EXPANSION BEARING DETAILS

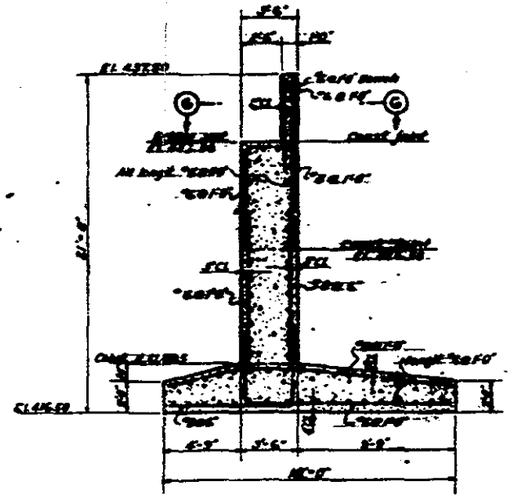


SECTION E-E

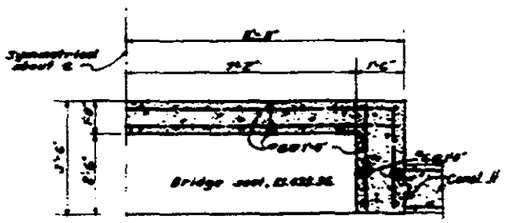
SECTION F-F — SIMILAR BUT OPP HAND



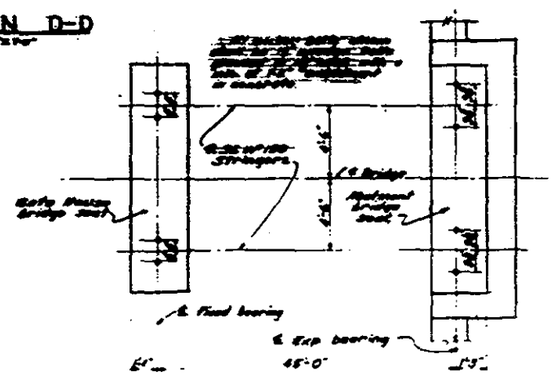
SECTION C-C



SECTION D-D



SECTION G-G



ANCHOR BOLT PLAN

NOTES

For general notes, see sheet No 252.
For payment item numbers see sheet No 252 1294

Record Drawing
Contract No. DA-19-016-CIVENG-60-2

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

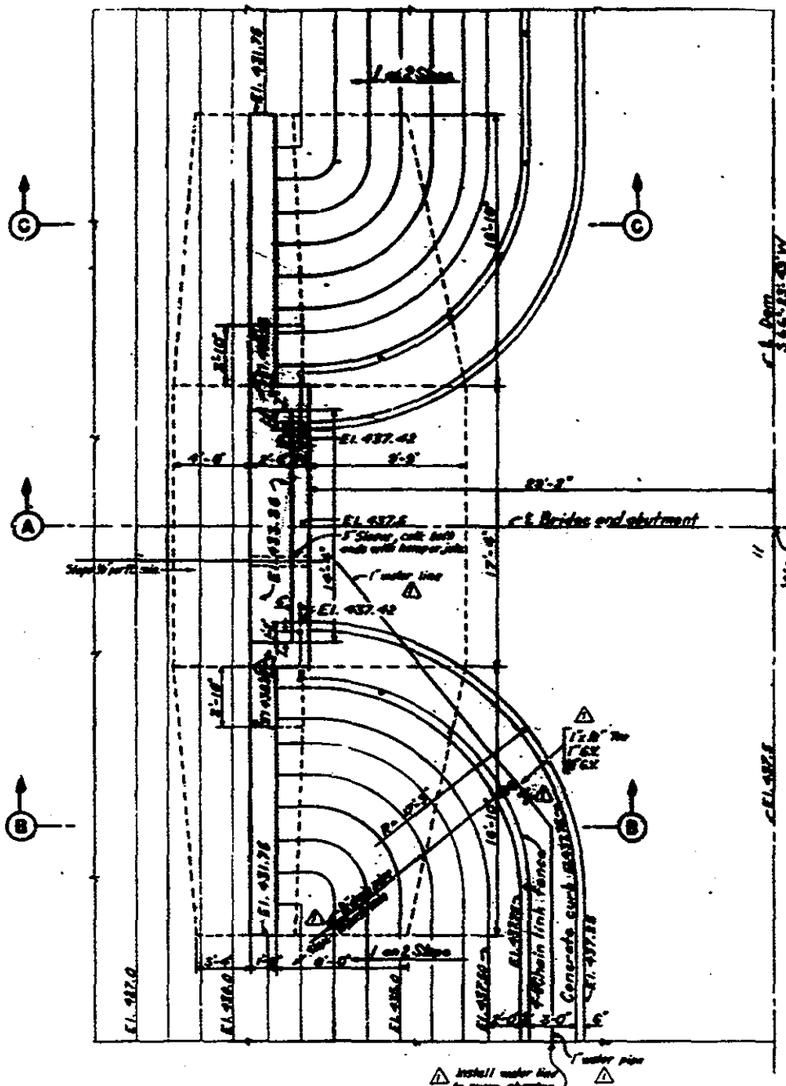
MERRIMACK RIVER FLOOD CONTROL
HOPKINTON-EVERETT RESERVOIR
HOPKINTON DAM
SERVICE BRIDGE - STEEL REINFORCEMENT
ABUTMENT
CONTOOCOOK & PISCATAQUOG RIVERS NEW HAMPSHIRE

DATE JULY 1959

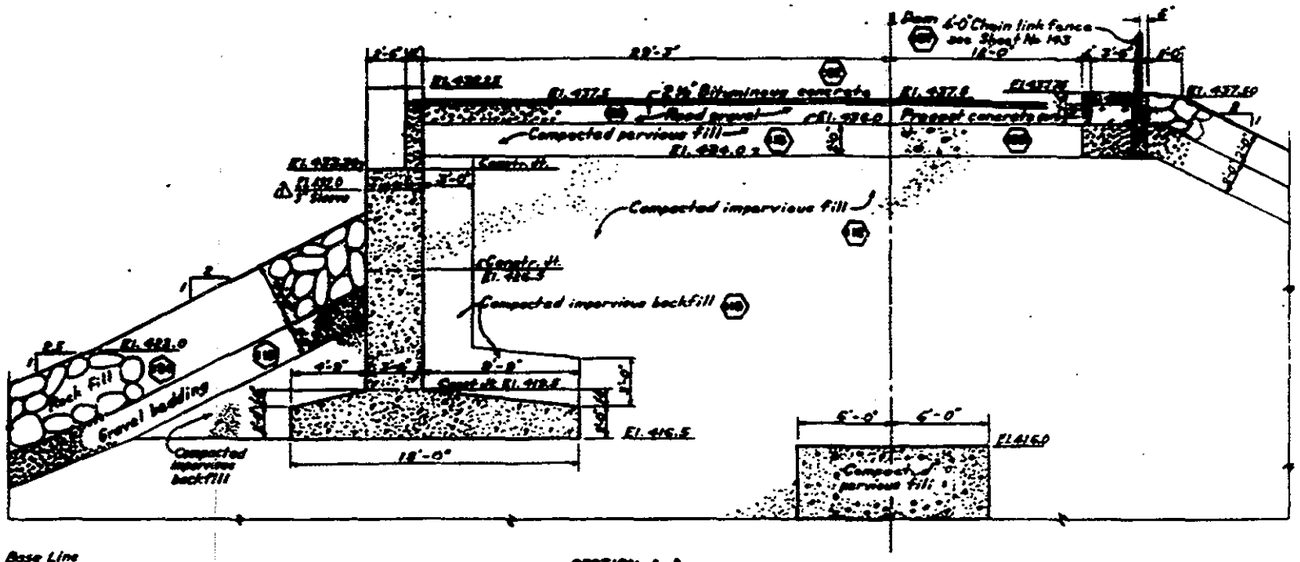
DIV. C.E. DEPUTY DIVISION ENGINEER

SCALE AS SHOWN SPEC. NO. CIV. ENG.-16-015-60-1

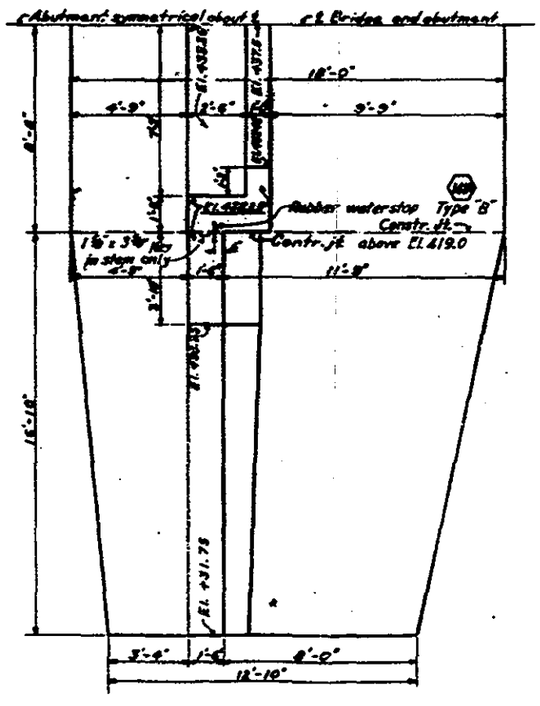
DRAWING NUMBER
MER-356



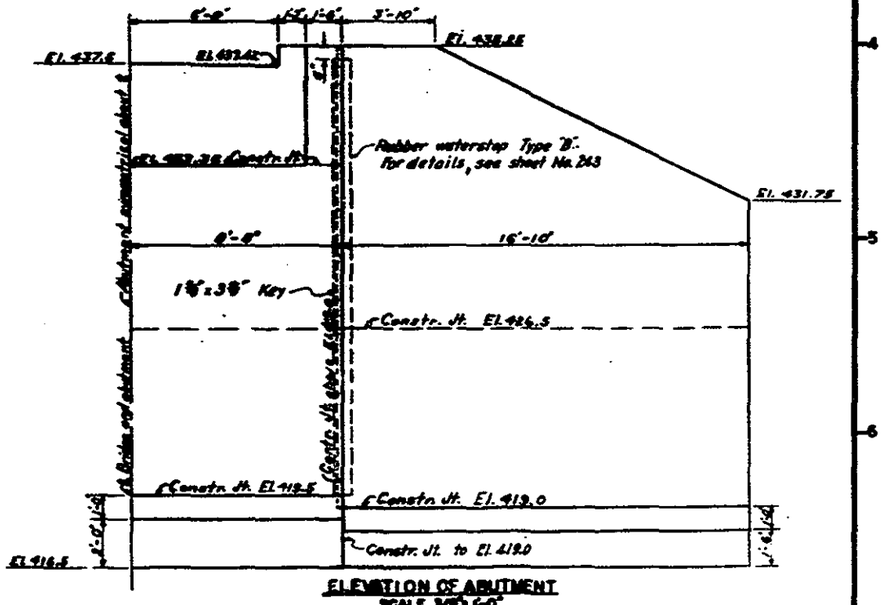
PLAN
SCALE 1/4"=1'-0"



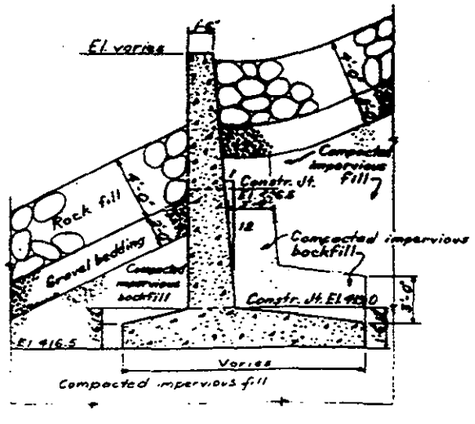
SECTION A-A
SCALE 1/4"=1'-0"



HALF PLAN OF ABUTMENT
SCALE 3/8"=1'-0"



ELEVATION OF ABUTMENT
SCALE 3/8"=1'-0"



SECTION E-B & C-C
SCALE 1/4"=1'-0"

NOTES:
Elevations refer to Mean Sea Level Datum.
All concrete in Bridge Abutment will be paid for under Item No. 136.
For steel reinforcement, see Sheet No. 293
For Service Bridge Plan and Details, see Sheet No. 294
Figures in hexagons indicate item numbers under which payment will be made.
For Construction and Contraction joint details see Sheet No. 263

Record Drawing
Contract No DA 19-016 CIV ENG 60-2

1	10/59	Water line, gate valves and sleeves added	
NO.	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DIV. ENGR. P.L.S.	DIV. ENGR. R.R.	DIV. ENGR. C.P.M.

MERRIMACK RIVER FLOOD CONTROL
HOPKINTON EVERETT RESERVOIR
HOPKINTON DAM
SERVICE BRIDGE
ABUTMENT DETAILS
CONTOOCOOK & PISCATAQUOG RIVERS NEW HAMPSHIRE

CHIEF, CONSTRUCTION DIV. | DEPUTY DIVISION ENGINEER | DATE JULY 1959

SCALE: AS SHOWN | SPEC. NO CIV ENG-19-016-60-1

DRAWING NUMBER
MER-1-1355

SHEET 292

APPENDIX D

LOAD RATING CALCULATIONS

RATING ANALYSIS

Hopkinton Service Bridge
Hopkinton Dam
Hopkinton

August 11 1997

RATING SUMMARY TABLE

	INVENTORY (TONS)		OPERATING (TONS)	
DECK	**47.88**	**Control**	**79.50**	**Control**
GIRDERS	**69.99**		**109.06**	

RATING ANALYSIS

Hopkinton Service Bridge

ELASTIC SECTION MODULI

A. STEEL GIRDER

GEOMETRY

	Width (in)	Height (in)
Top Flange	11.98	0.94
Web	0.63	33.97
Bottom Flang	11.98	0.94

SECTION PROPERTIES

	Area (in2)	y (in)	Ay	dy	A(dy)2	Ix (in4)
Top Flange	11.26	35.38	398.42	17.46	3431.03	0.83
Web	21.40	17.93	383.61	0.00	0.00	2058.00
Bottom Flang	11.26	0.47	5.29	-17.46	3431.03	0.83
TOTAL	**43.92**		**787.33**		**6862.06**	**2059.66**

CALCULATIONS

Moment Arm,	
Y = Ay/A =	17.93 in
Moment of Inertia,	
I total = Ix + A(dy)2 =	8921.72 in4
Section Modulus,	
S top = I total/Y top =	497.72 in3
S bottom = I total/Y bot =	497.72 in3

B. COMPOSITE GIRDER

GEOMETRY

Concrete Slab Thickness (in)	8.50
Effective Flange Width (in) *	85.00
Modulus Elasticity Ratio, n #	10.00

*LRFD Part 4, Composite Sections, p. 4-6 Effective Flange Width (c) the distance to the edge of slab.
AASHTO Standard Specifications for Highway Bridges, 10.38.1.3 and .4

SECTION PROPERTIES

	Area (in2)	y (in)	Ay	dy	A(dy)2	Ix (in4)
Steel	43.92	17.93	787.33	-13.21	7660.60	8921.72
Concrete	72.25	39.16	2829.31	8.03	4657.17	435.01
TOTAL	**116.17**		**3616.64**		**12317.77**	**9356.72**

CALCULATIONS

Moment Arm,		
Y = Ay/A =	31.13	in
Moment of Inertia,		
I total = Ix + A(dy)2 =	21674.50	in4
Section Modulus,		
S conc = I total/Yconcrete	1765.22	in3
S top = I total/Y top =	4593.38	in3
S bottom = I total/Y bot =	696.23	in3

C. COMPOSITE GIRDER - CREEP

GEOMETRY

Concrete Slab Thickness (in)	8.50
Effective Flange Width (in) *	85.00
Modulus Elasticity Ratio, n #	30.00

*LRFD Part 4, Composite Section, p. 4-6 (c) the distance to the edge of the slab 2'-7"

AASHTO Standard Specifications for Highway Bridges, 10.38.1.3 and .4 (3 times N= 30)

SECTION PROPERTIES

	Area (in2)	y (in)	Ay	dy	A(dy)2	Ix (in4)
Steel	43.92	17.93	787.33	-7.52	2483.87	8921.72
Concrete	24.08	39.16	943.10	13.72	4530.12	145.00
TOTAL	**68.01**		**1730.43**		**7014.00**	**9066.72**

CALCULATIONS

Moment Arm,		
Y = Ay/A =	25.44	in
Moment of Inertia,		
I total = Ix + A(dy)2 =	16080.72	in4
Section Modulus,		
S conc = I total/Yconc =	895.11	in3
S top = I total/Y top =	1545.48	in3
S bottom = I total/Y bot =	631.98	in3

STRESS ANALYSIS

GIRDER LOADS (kip-ft)

Dead Load Moment (from page D9)	232.37
Superimposed Dead Load Moment (from page D9)	39.74

ALLOWABLE STRESSES **

fc (compression) - inventory	1.20 ksi
fc - operating	1.90 ksi
fs - inventory	18.00 ksi
fs - operating	24.50 ksi

** AASHTO Manual for Maintenance Inspection of Bridges, Tbls. 5.4.2 A and B, 5.4.5

DEAD LOAD STRESS - STEEL GIRDER

f top=M/S=232.37(12)/497.7	5.60 ksi
f bot =232.37(12)/497.72 =	5.60 ksi

SUPERIMPOSED DEAD LOAD STRESSES - COMPOSITE GIRDER

f conc =39.74(12)895.11 =	0.53 ksi
f top =39.74(12)/1545.48 =	0.31 ksi
f bot =39.74(12)/631.98 =	0.75 ksi

AVAILABLE LIVE LOAD STRESSES - INVENTORY

f conc = 1.2 - 0.53 =	0.67 ksi
f top = 18 - 5.6 - 0.31 =	12.09 ksi
f bot = 18 - 5.6 - 0.75 =	11.64 ksi

AVAILABLE LIVE LOAD STRESSES - OPERATING

f conc = 1.9 - 0.53 =	1.37 ksi
f top = 24.5 - 5.6 - 0.31 =	18.59 ksi
f bot = 24.5 - 5.6 - 0.75 =	18.14 ksi

CALCULATIONS

Distribution Factor = 1.29

Distributed Maximum Moment, *
M max = DFx M live load = 347.46 k-ft

Distr. Max Live Load Stress (composite section),
f live load = M max/S min = 5.99 ksi

INVENTORY RATING

Stress Available for Live Load / Stress Actual due to HS20 Loading x Wt. of HS20 Truck =

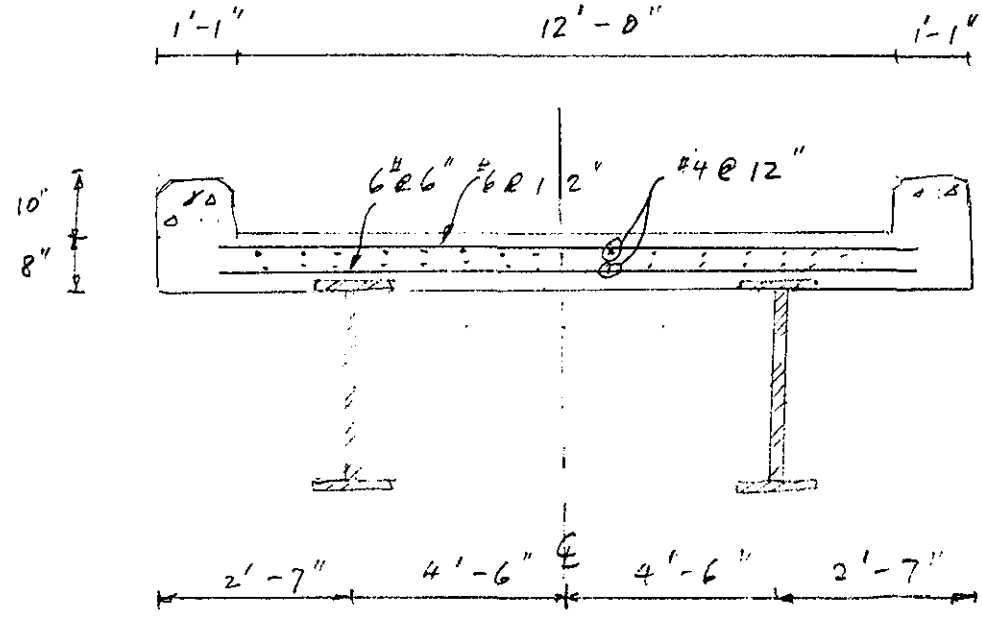
11.64 ksi / 5.99 ksi x 36 ton **69.99 ton**

OPERATING RATING

18.14 ksi / 5.99 ksi x 36 ton = **109.06 ton**

* AASHTO Standard Specification for Highway Bridges, Appendix A

SUBJECT Hopkinton Service Bridge
COMPUTATION Bridge Deck Rating Analysis
COMPUTED BY ff CHECKED BY LB DATE 8/12



Deck Rating

GR40 Reinforcing Steel AASHTO B, 5.4.4

$M_u = \phi M_n = \phi A_s f_y \left(d - \frac{a}{2}\right) = 0.9(0.88)(40)\left(6.625 - \frac{1.15}{2}\right)$
$= 191.66$ k-in
$= 15.97$ k-ft

$A_s = 0.88$ in² (#6@6")

$a = \frac{A_s f_y}{.85 f'_c b} = \frac{0.88(40)}{0.85(3)(12)} = 1.15"$

$d = 8\frac{1}{2}" - 1\frac{1}{2}" - \frac{.75}{2}" = 6.625"$

Dead Load, DL $= \frac{(8\frac{1}{2})}{12} \times 1' \times 150$ lb/ft³ $= .106$ k/ft

Deck $= 14.167 \quad (.106)\left(\frac{1}{2}\right) = 0.751$ kips

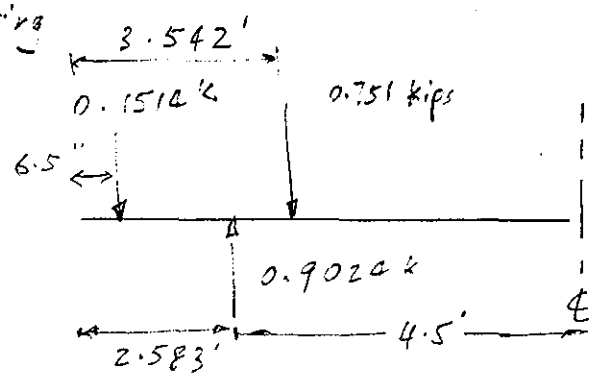
Curb $= (1)\left(\frac{13}{12}\right)\left(\frac{10}{12}\right) 150 \frac{lb}{ft^3} = 0.135$ kips

Rail $= .1$ ft³ $(165$ lb/ft³$) = 0.016$ kips

0.902 k $= R_L$

SUBJECT Hopkinton Service Bridge
COMPUTATION Bridge Deck Rating Analysis
COMPUTED BY FF CHECKED BY LB DATE 8/12

Deck Rating



$(+M_{@\,\text{℄}})\quad M_{DL} = -0.1514^{k}(6.542') - 0.751(3.542') + 0.9024(4.5)$

$= 0.4105$ k-ft

M_{LL} (AASHTO 3.24.3.1, HS-20) $= \left(\frac{S+2}{32}\right) D_{20}$

= Moment in foot-pounds per foot of width of slab

S = depth of the member: concrete deck

$S = 9\text{ ft} - 1' + 9''$

$= 8.75'$

$M_{LL} = \left(\frac{8.75+2}{32}\right)(16000\text{ lb}) = 5.375$ kip-ft

Support (neg.) $M_{DL} = -0.1514\left(2.583' - \frac{6.5}{12}\right) - .106(2.583)\left(\frac{2.583}{2}\right)$

$= -0.3091 - 0.3536$

$= -0.6627$ kip-ft.

SUBJECT Hopkinton Service Bridge
COMPUTATION Bridge Deck Rating Analysis
COMPUTED BY FF CHECKED BY LB DATE 8/12

Deck Rating (cont)

(a) Operating Rating of Sections Governed by Max. Strength (AASHTO B, 5.5.1)

Max Strength, $M_u \geq 1.3 [D + RF (L+I)]$

$15.97 \text{ k-ft} > 1.3 [0.4105 + RF (5.375 + 0)]$

$R.F. \leq [15.97 - 1.3(0.4105)] / 5.375 \times 1.3 = 2.21$

$R.F. \leq 2.21$

Rating = 2.21 (36 ton) = 79.5 T ← OPERATING

(b) Inventory Rating

$M_u \geq 1.3 [D + 5/3 RF (L+I)]$

$15.97 \text{ k-ft} \geq 1.3 [0.4105 + 5/3 RF (5.375 + 0)]$

$R.F. \leq [15.97 - 1.3(0.4105)] / (1.3)(5.375)$

≤ 1.33

Rating = 1.33 (36 tons) = 47.88 T ← INVENTORY

SUBJECT HOPKINTON SERVICE BRIGDE

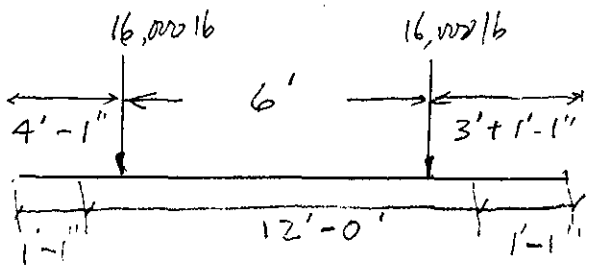
COMPUTATION BRIDGE DECK RATING ANALYSIS

COMPUTED BY FF CHECKED BY DATE

GIRDER RATING

Ref: AASHTO A, Fig. 3.7.6 A, Pg 22

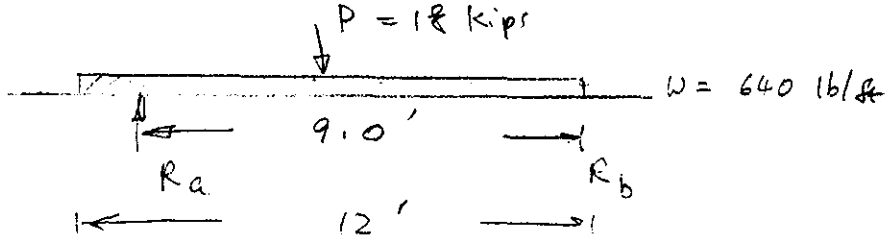
HS20



(a) Truck Load

$R_A = R_B = 16000$ lb (wheel load) $= W = \frac{1}{2}$ truck load

(b) Lane Load.



$18000 + 640\ lb/ft\ (12ft) = 25{,}680$ lbs

$R_a\ (9.0) = 25680\ (4.5)$

$R_a = 12{,}840$ lbs

1994 (AASHTO A, Appendix A3)

Span length = 45 ft, Moment Max $= \frac{260.4 + 278.3}{2}$

$= 269.35$ k.p-ft

(C) DISTRIBUTION FACTOR (LIVE LOAD)
(Ref: Table 3.23.1 pg 32)

D.F $= S/7.0$ S = AVE STRINGER SPACING in FEET

$= 9/7.0$ $= 9$ ft

$= 1.286$

± 1.29

SUBJECT Hopkinton Service Bridge
COMPUTATION Bridge Deck Rating Analysis
COMPUTED BY FF CHECKED BY LB DATE 8/12

Girder Rating (continued)

	Wt (lb/ft)
Girder 36W150	150
Deck $\frac{1}{2}(14'-2'') \times \frac{8\frac{1}{2}}{12''/ft} \times 150\ lb/ft^3$	753
Diaphragm (3 @ 11'-3") 185 42.7	
$3 \times 42.7\ lb \times 4.5'$ = 576.45 lbs	
Diaphragm (2 @ Ends) 12 20.7	
$2 \times 20.7\ lb \times 4.5'$ = 186.3 lbs	
Stiffeners (3) ST 7 WF 21.5	
$3 \times 3 \times 21.5$ = 193.5 lbs	
956.25 lbs	
Assumed Distributed Load	15
	918 lb/ft

$$M_{D.L} = \frac{wl^2}{8} = \frac{9.18\ (45)^2}{8} = \boxed{232.37\ k\text{-}ft}$$

S.I.D.E.R. Superimposed Dead Load

Curb and Rail	157

$$M_{S\ D.L} = \frac{wl^2}{8} = \frac{157(45)^2}{8} = \boxed{39.74\ k\text{-}ft}$$

SUBJECT Hopkinton Service Bridge
COMPUTATION Bridge Deck Rating Analysis
COMPUTED BY FF CHECKED BY LB DATE

GIRDER RATING (CONTINUE)

SHEAR

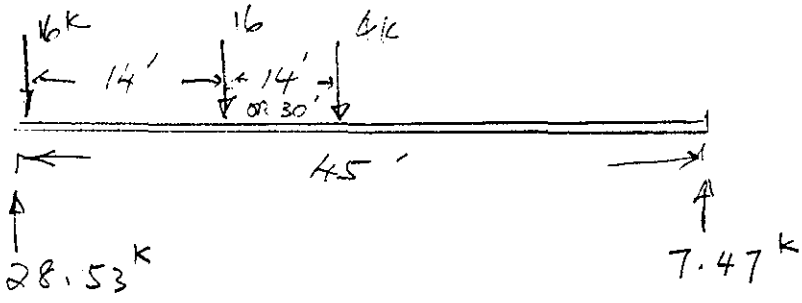
$V_{DL} = 1.075 \text{ k/ft} \times 45 \text{ ft}/2 = 24.19 \text{ kips}$

1994 AASHTO, TABLE 6.6.2.1-1

CARBON STEEL: $V_{allowable\ Inventory} = 11 \text{ ksi} (0.625 \times 33.97)$
$= 233.54 \text{ kips}$

$V_{allowable\ Operating} = 15 \text{ ksi} (0.625 \times 33.97)$
$= 318.47 \text{ kips}$

(1)



Rating Factor RF (inventory) $= \frac{233.54^{K} - 24.19^{K}}{28.53^{K}} = 7.34$

(OPERATING), RF $= \frac{318.47^{K} - 24.19^{K}}{28.53^{K}} = 10.31$

Rating for Shear, Inventory $= 7.34\ (36T) = 264.24\ T$

Operating $= 10.31\ (36T) = 371.33\ T$